



Enhanced High Temperature Integrated Power Module

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Purpose

Background

The interface between the utility grid and energy storage requires a reliable system to control the transfer of energy. An example is a transportable energy storage system that includes battery storage and power control, allowing it to be rapidly deployed and inserted into the grid.

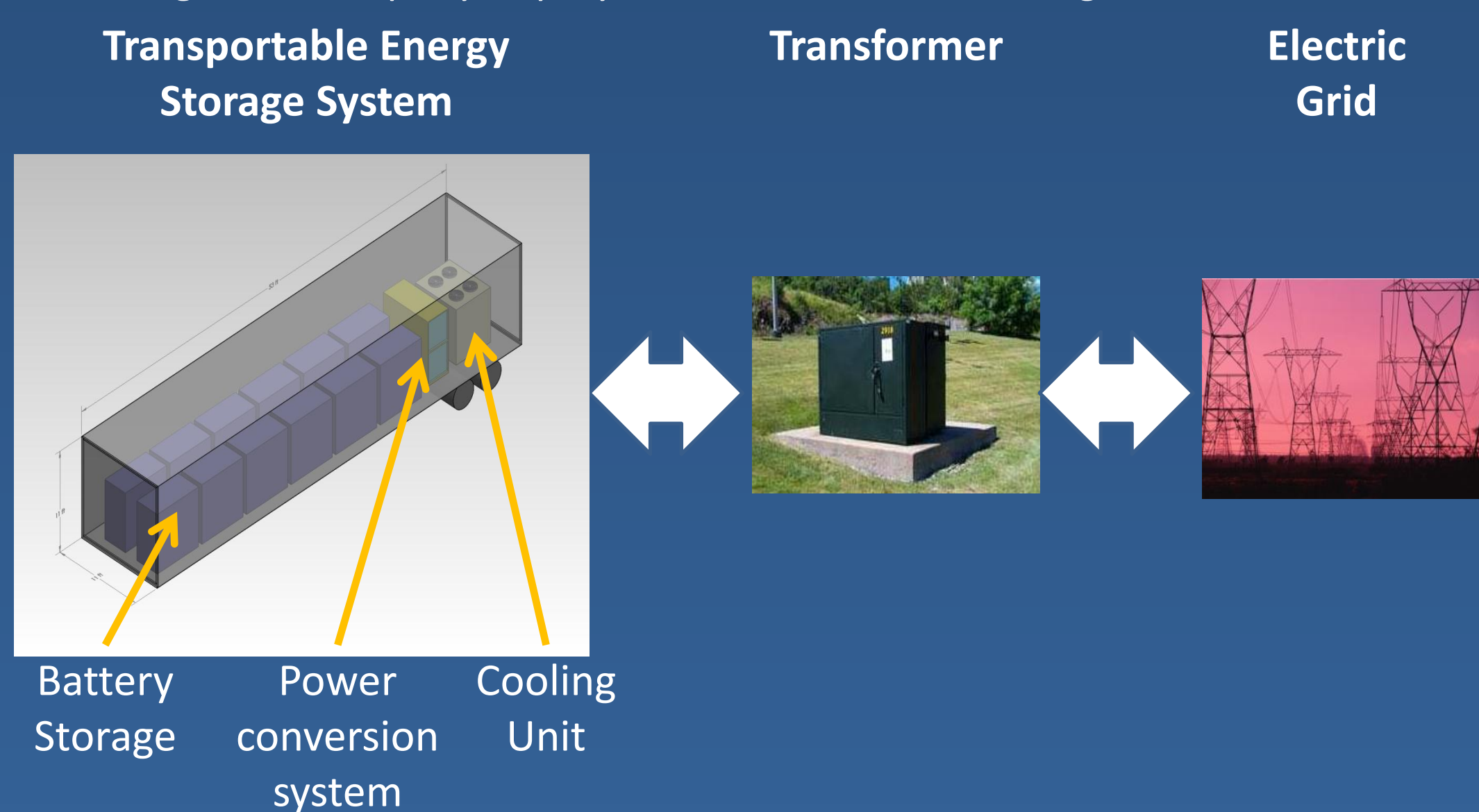


Figure 1: Transportable energy storage system with grid interface.

The power conversion system uses low temperature electronics that are kept cool by using large cooling units. The power density can be increased by removing the cooling units and creating more space for power conversion system components and battery storage. Subcomponents of the power conversion system include a controller, gate drive, and power stage modules.

Proposed Solution

These subcomponents can be built into a single integrated power module using high temperature electronics. Incorporating the devices into a single module will allow the cooling units to be reduced or removed in their entirety.

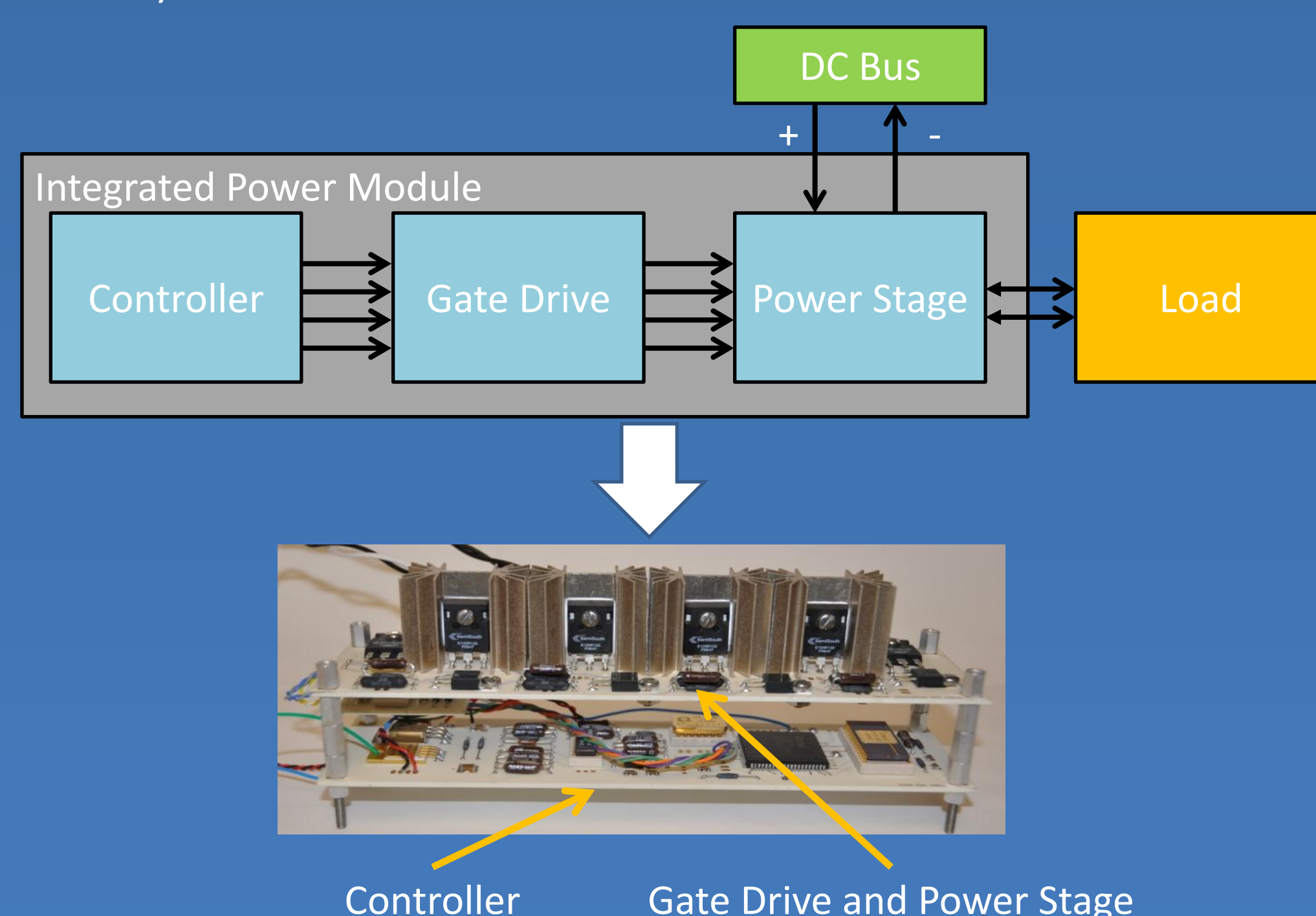


Figure 2: Integrated power module components

Project Goals

The purpose for this project is to develop a high temperature power module in a minimal design space. The design should increase power density and improve reliability. The system will be able to operate without the need for any external cooling at elevated temperatures.

Impact on DOE OE Energy Storage Mission

The project has been able to successfully reduce the overall power conversion system footprint by a factor of >10x. This reduction may be further increased if the cooling system for the transportable energy storage system is reduced or removed.

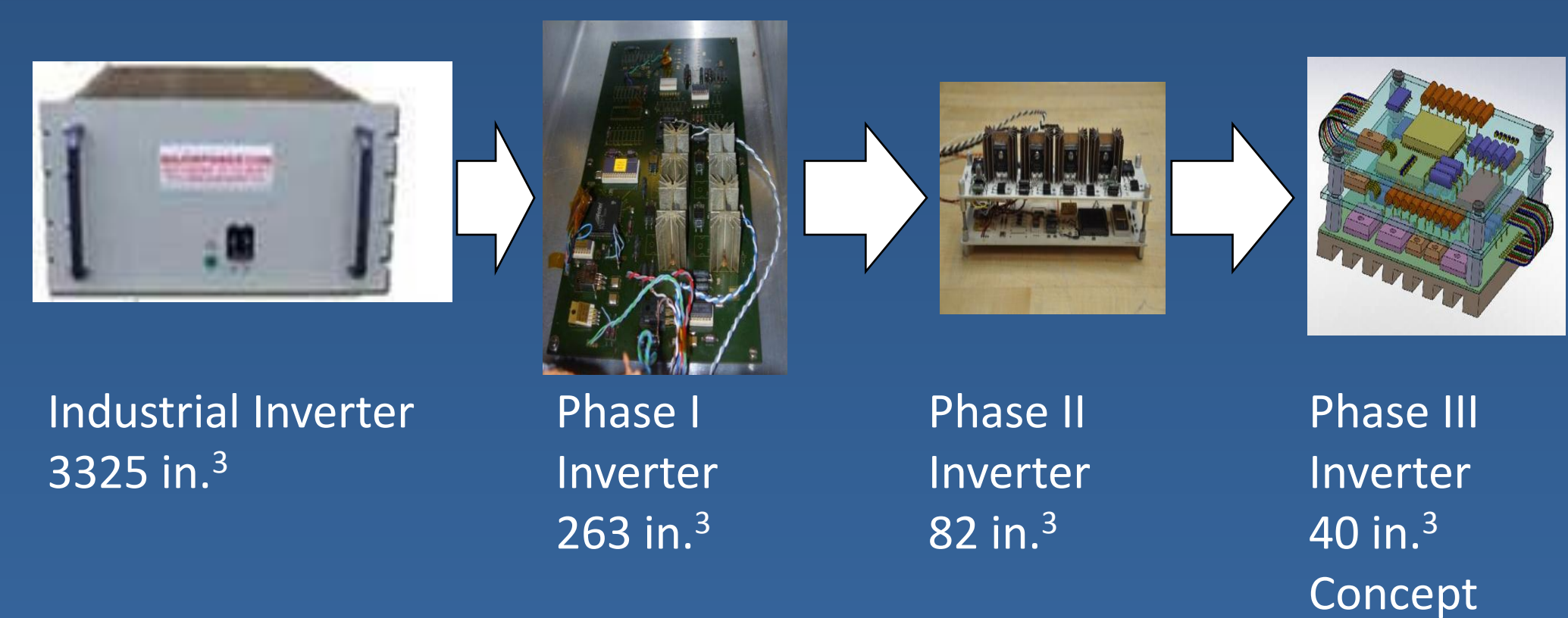


Figure 3: Reduction in Power conversion system size.

The current design (Phase II) has an increase in power density of >2x due to the reduction in size when compared to a comparably sized commercial inverter. The final design should provide an increased reduction in scale as the system is further optimized. Testing has shown the design to operate successfully at temperatures up to 240°C.

The controller system algorithm was improved in this phase, allowing the switching frequency to be increased, reducing the filtering requirements, and improving the harmonics on the system.

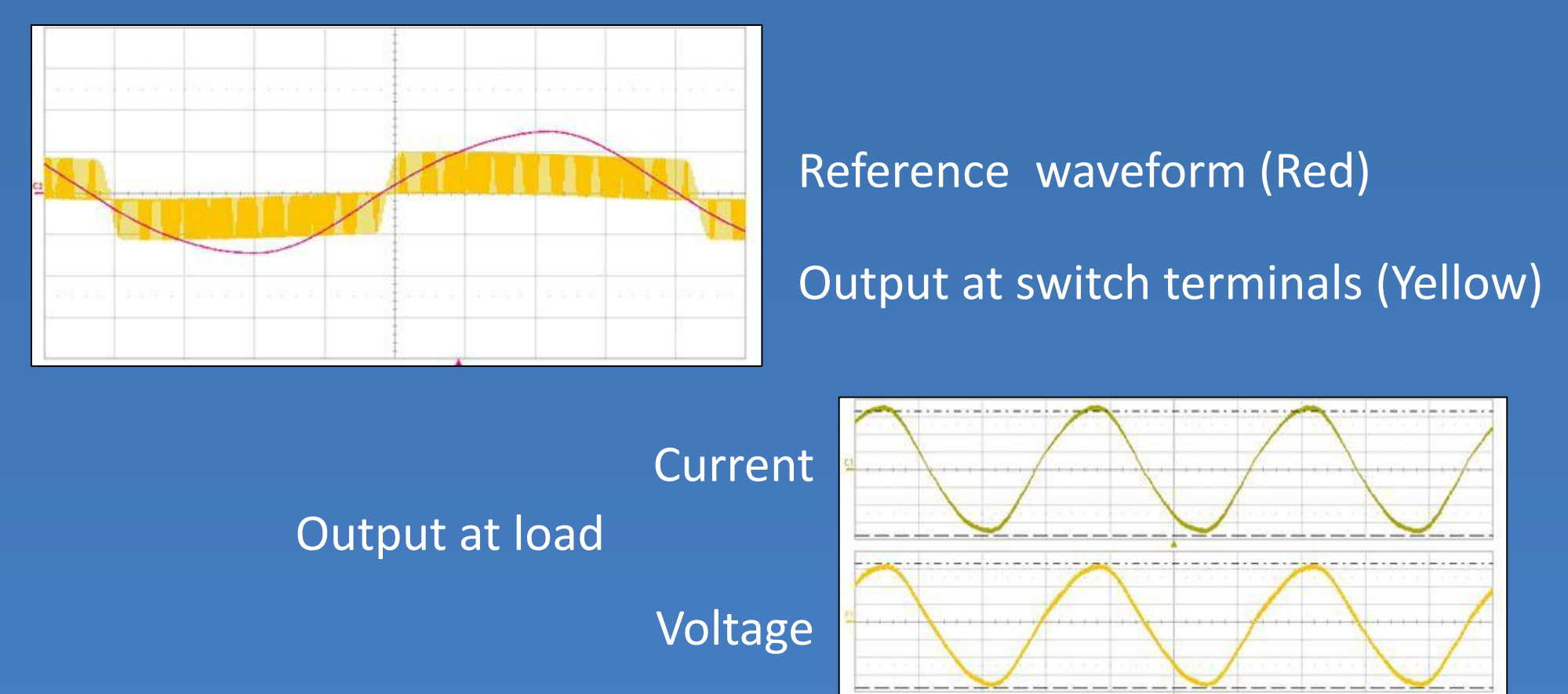


Figure 4: Integrated power module output at 200°C.

Future Work

As the project continues to advance, the focus will be to improve the reliability of the gate drive at high voltages. Once the component selection has been validated, the next step will be to build the final integrated power module.

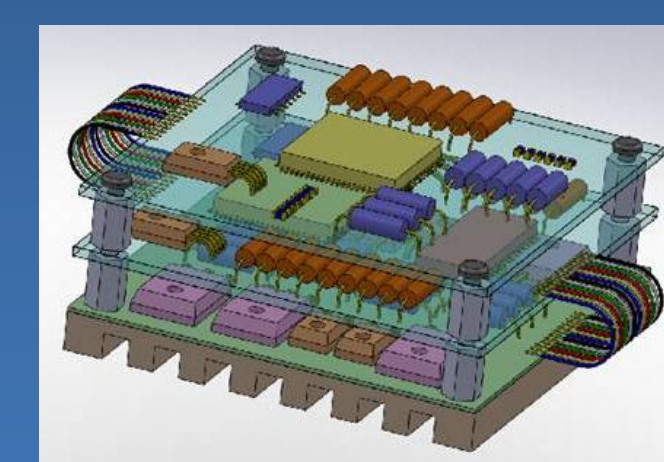


Figure 5: Conceptual design for an integrated power module.

The module may then be tested at elevated temperatures for extended periods to evaluate long term performance and reliability.